GROUND WATER MODELING

Base Case Model Runs

Ground water flow models of the shallow aquifers (Surficial and Intermediate aquifer systems) in Collier, Lee and Hendry counties were used to evaluate how well resource protection criteria could be met for future water demands under average and deficit rainfall conditions. Based on these results, water supply problem areas were delineated. Problem areas are defined as areas where the resource protection criteria were not met. Alternative water supply/demand modeling scenarios were developed to examine how well they might reduce the extent of the problem areas.

All three flow models use the U.S. Geologic Survey "Modular Three-Dimensional Finite-Difference Ground-Water Flow" (MODFLOW) code. The Collier and Hendry models were previously developed by the SFWMD and the Lee model was developed by a consultant under contract to the Lee County Regional Water Supply Authority. The models simulate ground water flow and associated ground water levels within the Surficial, lower Tamiami, Sandstone, and mid-Hawthorn aquifers for any given set of well withdrawals, canal configurations and precipitation.

Two water demand levels were examined using ground water flow models: (1) The 1990 permitted demand level, and (2) the 2010 projected demand level. The 1990 permitted demand level represents the total urban and agricultural water demand that was permitted by the District through the end of 1990. The 2010 projected demand level is based on estimates of population in 2010 and acreage that will actually be irrigated in 2010.

The 1990 permitted demand level is considerably higher than actual 1990 demand level because considerably more agricultural acreage was permitted in 1990 than was actually planted. Actual crop acreages are usually less than the permitted acreages due to the normal lags between permitting and planting. These lags vary in length, based on planting schedules, fluctuation in current and anticipated crop prices, long-range expansion plans, and short-term management decisions made by the growers.

Permitted acreage may run far ahead of the actual acreage in an area experiencing high growth in agricultural acreage. The difference between permitted acreage and actual acreage is somewhat smaller in areas experiencing slower growth in agriculture, such as Lee County. Because the 1990 permitted demand level is so much greater than the actual 1990, the projected 2010 demand level is only slightly higher than the 1990 permitted demand level.

All simulated irrigation demands varied with rainfall conditions based on meeting irrigation requirements as defined by the modified Blaney-Criddle method in the Basis of Review Permit Information Manual, Volume III (SFWMD, 1993). Public water supply and domestic self supply demands varied on a monthly basis based on historic monthly distribution patterns.

Two rainfall conditions were simulated to identify the difference between likely chronic problems, occurring under average rainfall conditions, versus problems expected only during droughts. Drought conditions were simulated for each county using the historic 12 month rainfall event causing simulated water level declines expected to be equaled or exceeded approximately once every 10 years on average. This rainfall event is called a 1-in-10 drought condition.

"Base case" model runs were simulated using both the 1990 permitted demand level (1990 base case) and the 2010 projected demand level (2010 base case). Assumptions for the 2010 base case represent what was expected to occur in the future without any additional water supply planning and regulation. The 2010 base case model runs assumed that future water users would obtain their water from the same aquifers as existing users. It also assumed that existing water users would utilize the same aquifers for both their current and future demands.

Base case model run results were evaluated to determine how well resource protection criteria had been met. The wetland protection criterion utilizes drawdowns in layer one of the model and is applicable only under wetlands. Water levels from a model run with no wells pumping (well package turned off) were compared to water levels with the wells pumping to determine drawdowns in each of the layer one model cells. Drawdowns in layer one of the model were evaluated to determine in which model cells the wetland criterion drawdown limit (one foot for more than one month) had not been met. Wetlands overlying these model cells were identified, and the total area of the wetlands where the criteria had not been met was calculated for each model run. The total area in which wetland criteria had not been

met (expressed in acres) was used to compare how well various model runs met the wetland protection criterion.

The seawater intrusion and general aquifer protection criteria specify minimum water levels for model cells. Model run results were checked for compliance with these criteria by directly comparing the water levels from each model run with the criteria levels. The model cells in which criterion levels had not been met were identified. Additionally, the number of months during a model run in which a criterion level had not been met within each model cell was observed and assigned to each cell as a weighting factor. The weighting factors from each model run were summed and then used as a relative index for comparing how well the various model runs had met the seawater intrusion and general aquifer protection criteria. Dimensionally, this relative index may be expressed in units of "cell months." For example, a model run in which water levels fell below a criterion level in one model cell for two months was reported to have a relative index of two cell months. A model run in which water levels fell below criterion levels in two model cells for two months in one cell and three months in the other cell would have a relative index of five cell months.

Alternative Modeling Scenarios

In addition to the base case model runs, several alternative water supply/demand modeling scenarios were simulated using the 2010 projected demand level. These alternative modeling scenarios were evaluated for their effectiveness in meeting the resource protection criteria in the same way as the base case model runs. The results from each alternative modeling scenario were compared to the results from the base case model run at the 2010 projected demand level. The effectiveness of each scenario compared to the base case was expressed as a percentage reduction in the total area not meeting the wetland protection criterion or as a percentage reduction in the relative index for the seawater intrusion and general aquifer protection criteria. For example, the total area where wetlands had not met the wetland protection criterion for each alternative modeling scenario was compared to the total wetland problem area for the base case model run at the 2010 projected demand level. The result was expressed as a percentage reduction in total wetland problem area compared to the base case model run.

Scenario 1 - Evaluate reduction of public water supply demands from the shallow aquifers

Two variations on this model scenario were simulated for both Collier and Lee counties. Public water supply demand is a relatively small component of the total demand in Hendry County, so scenario 1 was not simulated for Hendry County. All public water supply withdrawals were removed from the shallow aquifers in scenario 1a. This scenario eliminated any problems in not meeting the resource protection criteria due to public water supply withdrawals. In scenario 1b, the increase in public water supply withdrawals between the 1990 permitted demand level and 2010 projected demand level was removed from the shallow aquifers. Scenario 1b isolates the effect of the increased public water supply demand with respect to meeting the resource protection criteria. Although both modeling scenarios 1a and 1b remove the current or future public water supply demand from the shallow aquifers, neither scenario specifies nor simulates an alternative source for these demands. The most probable alternative source for these demands is the Floridan Aquifer System; however, simulation of flow in the Floridan cannot be done with the existing models.

A more detailed analysis must be performed with shifting the withdrawals of different user classes (agricultural, urban) to different sources.

Scenario 2 - Evaluate reduction of agricultural water use by increased irrigation efficiency

Three variations of this modeling scenario were simulated. In scenario 2a, the irrigation efficiency for small vegetable crops was increased to 75 percent for all users currently below that efficiency level. In scenario 2b, the irrigation efficiency for citrus was increased to 85 percent for all users currently below that level. Scenario 2c was a combination of scenarios 2a and 2b. All three model scenarios were simulated by reducing irrigation withdrawals for small vegetable and/or citrus crops in the model runs.

Scenario 3 - Evaluate increased use of reclaimed water

Scenario 3 assumed that all of the available supply of reclaimed water in the LWC Planning Area would be utilized to meet irrigation demands. The available supply of reclaimed water was defined as average of the three minimum flow months for each regional wastewater treatment plant in Lee County and the modeled portion of Collier County for the year 2010. This scenario was simulated by reducing well withdrawals and replacing them with reclaimed water.

Nearly all of the projected supply of reclaimed water in the LWC Planning Area is in Collier and Lee counties. Scenario 3 was not simulated in the Hendry County model because the projected reuse in Hendry County is insignificant.

Scenario 4 - Evaluate implementation of proposed long-term modifications of the Big Cypress Basin canal system

Simulated modifications to the Big Cypress canal system for scenario 4 included elimination of canals in the Golden Gate Estates South area and addition of control structures on the Miller and Faka Union canals directly north of Alligator Alley. Control elevations for the new structures were set at one foot below land surface to maintain higher water levels north of I-75. This scenario is specific to Collier County and was simulated with the Collier County model by adjusting the simulated canal levels accordingly. The proposed modifications to the Big Cypress canal system include facilities for backpumping water to the Golden Gate Estates North area and other routing of surface water through the canals; however, these modifications cannot be fully represented in the ground water model. This modeling scenario did not evaluate any flood protection aspects of the proposed modifications to the Big Cypress Basin canal system, but rather was an evaluation of ground water levels as related to water supply and wetland impacts only.

A watershed management plan will be developed by the Big Cypress Basin Board within the next year. This watershed management plan should be able to provide more detailed evaluations of the benefits of the proposed modifications.

Scenario 5 - Evaluate combination of Scenarios 1 and 3

This scenario has two variations. Scenario 5a combines scenario 1a, in which all water supply withdrawals were removed from the shallow aquifers, with scenario 3, in which irrigation withdrawals were partially replaced by reclaimed water. Scenario 5b combines scenario 1b, in which the increase in public water supply

withdrawals between 1990 and 2010 were removed from the shallow aquifers, with scenario 3.

Scenario 6 - Evaluate combination of Scenarios 1, 2c, and 3

Modeling scenario 6 had two variations: (1) scenario 6a, which combined modeling scenario 1a (remove all public water supply from the shallow aquifers), modeling scenario 2c (improving the irrigation efficiency of both small vegetables and citrus), and modeling scenario 3 (increase use of reclaimed water); and (2) scenario 6b, which combined modeling scenario 1b (remove **future** public water supplies from the shallow aquifers), modeling scenario 2c, and modeling scenario 3. Modeling scenarios 1a, 1b, and 3 involved urban water supplies and reclaimed water, neither of which are very large in Hendry County. Scenarios 1a, 1b, and 3 were not simulated for Hendry County. Similarly, modeling scenarios 6a and 6b were not modeled for Hendry County.